CPUC Rule 21 Workshop

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Overview

- Intelligent Energy Management Solution
- Services Offered/Capabilities
- Use Case #1 – Interconnection and Reliability
- Use Case #2 – Interconnection and Grid Health
- Lessons Learned – Regulatory and Technical
- Rule 21 – Phase 3 Synopsis
- Recommendations
- Conclusions

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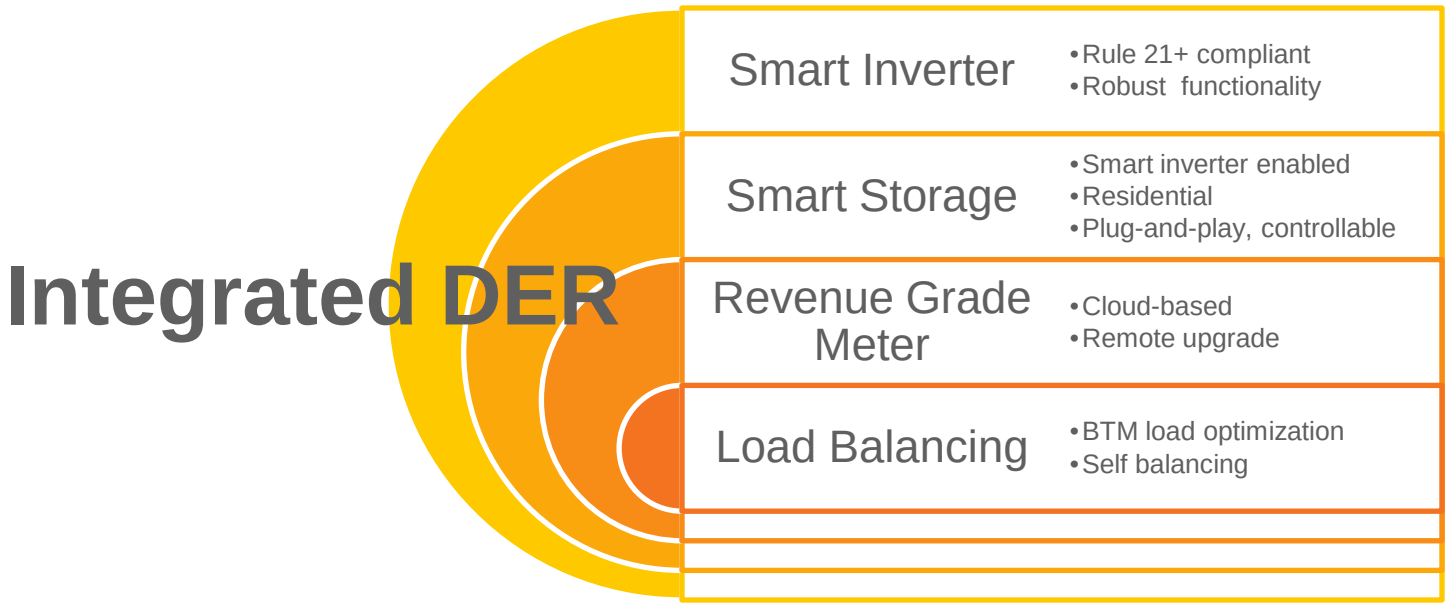
Intelligence at the Grid Edge

- ✓ 100% distributed, bi-directional comms., aggregated, networked, plug-and-play
- ✓ Distributed generation and load optimization behind the meter



Requires a systematic vs. patchwork approach to DER market development
~ "Create a network of smart systems"
~ "Focus on the PCC, not the technologies behind it"

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DER Services

Services	Features
Network Insight	
Production Data	PV/Storage Production Data
Grid Monitoring	Voltage, Frequency, PQ, Load Flow
Command and Control (“Distributed Resiliency and Control”)	
Production Control	Curtailment, Ramp Rate, Peak Power Limits
Coordinated Volt/VAR Support	Reactive Power Management
Professional Services (“PSO”)	
Implementation	Data Analysis, Systems Integration, Solution Design
Analytics and Visualization	Analytics, Forecasting, Visualization Tools

Services Should Not Be Free

- Impacts created by the DER should be offset as a good grid participant
- Services beyond that level must be compensated for
- The challenge is determining what is a reasonable level
- California’s Rule 21 requirements are the most severe globally

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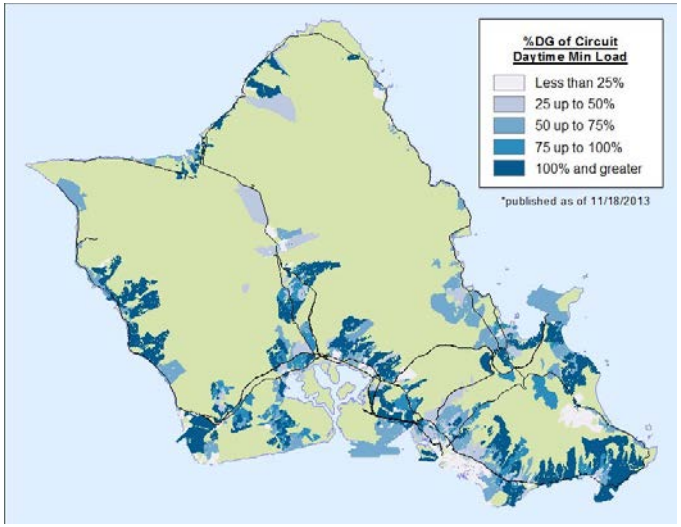
Use Case #1 – Interconnection and Reliability

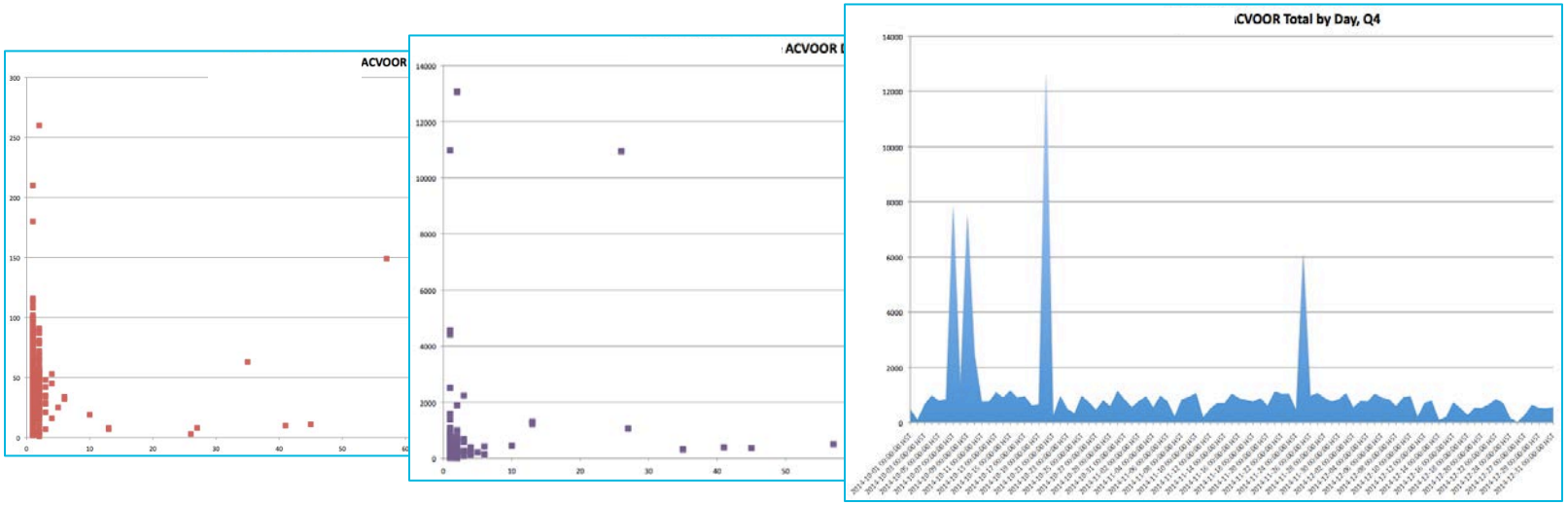
- Hawaiian Electric (HECO) experienced two frequency events in 18 months on Oahu
- Modeling suggested changes were needed to voltage and frequency ride through
  - HECO worked with inverter industry to develop a two stage implementation plan
  - Interim settings based on existing UL 1741 certifications
  - Phase 2 settings required new UL 1741 certifications

1. **Completed remote upgrades for ~800,000 inverters (system reliability)**
2. **Voltage analysis freed up interconnection queue for ~5,000 PV systems (streamline interconnection)**



Use Case #2 – Interconnection and Grid Health

- **Planned installations of solar PV in new development area prompted distribution upgrades required by IOU**
- **Enphase analyzed feeder conditions to determine need for new upgrades**
  - Voltage-out-of-range was utilized to isolate “problem” areas
- **Analysis concluded that existing capacity was more than sufficient on most feeders**
  1. **Showed minimal need for upgrades (grid health)**
  2. **Streamlined timing and cost of interconnection (interconnection)**
  3. **Forecast upgrade requirements at various penetration levels (grid health)**



Learning from “Doing” - Regulatory

- **~$45-60M in cost savings in HI that cannot be accounted for in E3 avoided cost model, or <u>any</u> current “value of solar” model**
  - Valuable services will be created that cannot be anticipated, even today
  - Flexible DER tariff needs to accommodate evolving market and services

- **Avoided cost methodology is a “limiting” factor in recognizing potential of “smart” PV**
  - Motivates patchwork approach to procurement (DRP), not system-based approach
  - Consider portfolio approach to rate reform that incentivizes DER development (i.e. TOU, DER tariff, NEM 2.0 etc.)

- **Locational value does not capture system-level benefits associated with “smart” PV**
  - Examples: streamlining interconnection, maintaining system reliability, forecasting upgrade requirements are benefits to all ratepayers

Networked “Smart” PV Provides Value Unimagined By the Existing Regulatory Construct

Learning from “Doing” - Technical

- **Frequent remote updates or command/control is necessary to address changing grid conditions**
  - Residential PV curtailment is a real possibility in HI, will require remote upgrades and control
- **% of minimum daytime load (MDL) is a poor metric for circuit handling capacity**
  - Voltage-out-of-range exists at all penetration levels in HI
  - Feeder level voltage data from smart PV critical to diagnose health of circuit
- **“Set it and leave it” is a bad strategy if grid reliability/resiliency are priorities**
  - Integrated DER even without storage can be as “smart” as four-quadrant control storage

Visualization, Monitoring and Control of Networked PV is “Necessary”

Rule 21 - Phase 3 Synopsis

- **Phase 1 captures virtually all functionality necessary today to interconnect as a good grid participant**
  - Autonomous functions paramaterized to maintain system reliability and voltage regulation
- **National standards are now ahead of Rule 21 in addressing topics identified in Phase 2 and 3**
  - IEEE 1547 (Interconnection), IEEE 2030.5 (Communications), and IEEE 2030.6 (7) (Microgrids), UL1741 SA (2015), UL 1741 Full Revision (2016)
- **Phase 3 discussion on additional functions is premature and potentially conflicts with National standards work currently underway**
- **Phase 3 will add even more cost on inverter industry with no path to monetization**
  - Costs are imposed, regardless of whether they are mandatory or not

Functionality – Current Phase 1 and 2 Backlog

Functions	Rule 21 Phase(s)	Fixed Cost	Recurring Service Delivery Cost	Production or Energy Losses
Enhance System Stability				
Enhanced Voltage and Frequency Ride-Through	1 (2 Adjs)	High	Auto	None
Anti-Islanding	1	High	Auto	None
Ramp Rates	1 (2 Adjs)	High	Auto	Yes
Soft-Start	1 (2 Adjs)	High	Auto	Yes
Voltage Management and Volt/VAR Optimization				
Fixed Power Factor	1 (2 Adjs)	High	Low	Yes
Dynamic Volt/VAR	1 (2 Adjs)	High	High	Yes
Data Services				
Production Data	2	High	Medium	None
Grid Data	2	High	Medium	None

Phase 2 Should Enable Adjustment to Phase 1 Settings

Functionality – Phase 3 Mandated DRAFT

SIWG Phase 3 DER Functions DRAFT Mandatory List (9/17/2015)	Category	Fixed Cost	Recurring Service Delivery Cost	Production or Energy Losses
Monitor DER Status and Output: (Section 3)	Data	High	Yes	None
Command DER to Connect or Disconnect: (Section 4)	Real Power	High	Yes	Yes
Set Real Power: (Section 6)	Real Power	High	Yes	Yes
Set Energy Storage charge and discharge rates: (Section 7)	Real Power	High	Yes	Yes
Frequency-Watt: (Section 10)	Real Power	High	Yes	Yes
Storage Frequency-Watt: (Section 10)	Real Power	High	Yes	Yes
Voltage-Watt: (Section 11)	Voltage Mgmt and Volt/VAR Opt	High	Yes	Yes
Dynamic Reactive Current Support: (Section 13)	Voltage Mgmt and Volt/VAR Opt	High	Yes	Yes

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Phase 3 Recommendations

- **Prioritize developing a "compensation" mechanism to allow for the provision of grid services from "smart" systems**
  - Loss of real power needs to be addressed now, not later and in another proceeding
  - IDER will take too long to address more immediate requirements (i.e. "multi-year process")
  - Grid services tied to system benefits (i.e. streamlining interconnection) need to be considered and compensated for
- **Establish contractual framework necessary for the provision of grid services**
  - Privacy, data sharing, right-to-control, agency agreement between DER aggregator and IOU
- **Align proceeding work with CAISO to ensure aggregated grid services can be provided both in the retail and wholesale markets**
- **Defer Phase 3 functions to National standards bodies**
- **Delete Phase 3 functions from the operation priority list in the CSIP Implementation Guide**

Conclusion

- **Enphase use cases clearly illustrate that “value” is created from the utilization of networked and pervasive systems employing smart inverter technology**
- **Without compensation, solar PV costs will be higher as a result with no system benefits realized as a result of Phase 1 requirements**
- **A regulatory framework needs be developed that recognizes the value of a technology that can provide limitless functionality to the grid (i.e. flexible DER tariff)**
- **Technology standards are now being addressed in IEEE and UL**
- **The CPUC should now shift its focus from technical to regulatory standards for the health and benefit of the DER market**